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CHAPTER 9

An Analysis of 17th-century Ethiopian Pigments

Anaïs Wion

Two Masterpieces of the First Gondarine Style¹

MS B.N. Eth. Abb. 114 is an illuminated volume of the *Miracles of Mary* (*Tä'ämrä Maryam*) in the French National Library, which depicts thirty-three miracles.² The palaeography consists of a beautiful *gwelḥ*, and the iconographic cycle is attributed to the First Gondarine period.³ The paintings illustrate the miracles, with one to two pages dedicated to each of the paintings. Following the text, the same painter has added fifteen full-page images illustrating scenes from the New Testament as well as illustrations portraying saints and the first owner of the manuscript.

Pigment samples of bright red, lemon yellow, blue, green, black, brown and flesh pink (Plate 6) were taken from these paintings. Numerous blank pages remained after creating the original commission, and as a result fifty-seven paintings, using a lightly-coloured palette and angular drawings, were executed on these pages. These paintings are attributed to the Second Gondarine style. Blue was the only colour sampled from these latter paintings, as the purpose of the study was to focus on the second half of the 17th century.

The manuscript is not dated. There is no colophon nor any marginal texts, and the name of the first owner has been erased. The dedication panels are now occupied by the names of King Hezqyas (1789–1801) and his wife Queen Wäldä Qirqos. The second set of paintings might date from this period. In only one place (f. 3r) is the first owner's name legible as Amläkawit. In the first set of paintings this donor is depicted in an image where she is praying and facing the codex of the *Miracles of Mary* (f. 87v). She is wearing a beautiful head-dress, a blue striped coat and a blue quadrilled skirt.⁴ The owner appears to have been a member of the royal family; although the name in the dedication has been erased and replaced by that of Queen Wäldä Qirqos the remainder of the original dedication reads as follows: 'How our Queen ... is praying in front of Our Lady Mary'. A servant with a dark complexion is following her with a fly-swatter.

Only one woman with the name Amläkawit is found in primary sources, a daughter of King Yohännis. She died in 1668,⁵ was buried on Mesraha island,⁶

and was the maternal grandmother of King Yoſtoſ (1711–16),⁸ according to different versions of the Chronicles.

Another manuscript of the *Miracles of Mary* is stylistically very similar to MS Ethiopien d'Abbadie 114, and appears to have been completed by the same painter. Now in a private collection, it is said to have been ordered by Mädhin Mogasa and her daughter Amläkawit.⁹ Could Mädhin Mogasa be the royal name of Queen Sablä Wīngil? King Yohānnis' royal name is Aläf Sägäd, so the royal name of his queen should have been Aläf Mogasa.¹⁰ There is an exception to every rule, however, and some kings had more than one royal name, as well as more than one wife. This could have been the case of Yohānnis I. These codices also have stylistic similarities with three icons including triptych IES n. 3,492,¹¹ the small pendant double diptych IES n. 3,794,¹² and triptych IES n. 4,755.¹³ The latter triptych is dedicated to Dama Kristos and his wife Amata Hawaryat, and although it is obviously by a different hand than the previous icons, it still follows the same stylistic rules. Perhaps these artefacts are from the same workshop, representing two or three painters working together at one time or the relationship between a master and student.

The second masterpiece consists of the Abbä Antonios mural paintings,¹⁴ which are stylistically similar to the manuscript and the paintings mentioned above. This mural painting is attributed to the reign of Yohānnis I (1667–81). According to the *Short Chronicle*¹⁵ and to the priests of Abbä Antonios, the church was founded by King Yohānnis I. A date *post quem* is given for dating this homogeneous pictorial work.¹⁶ Only two other mural paintings of the First Gondarine style are known; both of them, Däbrä Sina Gorgorä¹⁷ and Qoma Fasilädäs,¹⁸ are complete.

The Abbä Antonios church, located north of Gondär, was visited in the early 1930s by M. Griaule and M. Leiris, who removed the murals from the wall of the *mäqdäs* and replaced them with copies. These murals are now stored in the Museum of Mankind.¹⁹ Since they entered the French National Collection the majority have been restored, first in the early 1940s and then in 1989. In order to yield more accurate results in analysis, sampling was performed on paintings that were either not restored or only minimally restored (Plate 7).

Three paintings were chosen. The first is the head of Sarah (part of eastern wall), the second the Virgin with Child (western wall), and the third the Priests of Heaven (highest section).

Raman Laser Microspectrometry

Raman microspectrometry is named after Dr Raman, an Indian scientist who won the Nobel Prize in 1930. The Raman effect occurs when a material is illuminated by a coherent light, created today by a laser. This light is scattered and displays shifts in frequency resulting from the vibrations of the atoms in the material. These vibrations depend on the nature of the atoms and on the distance between them. Thus the Raman spectrum of each material (the

spectrum of its frequency shifts) is characteristic of its unique chemical composition.

Raman analysis requires microscopic samples of pigments (from 5 to 10 μ) which are taken from already-damaged areas of the painting and then analysed in the laboratory.²⁰ In manuscripts these samples are typically only visible under the binocular microscope. In mural paintings, however, it is quite easy to find large areas of loss. Each sample is placed between two glass slides and analysed. Raman analysis is a non-destructive technique, so samples can be studied many times, thus benefitting from continuous advances in the technology²¹ as well as from other observation techniques.²²

Analysis

The results are presented colour by colour.

Red All samples of the red pictorial layer are mercury sulphide (HgS), which comes from cinnabar or vermilion.²³ It is pure in the bright red areas. When mixed with black, vermilion appears as various shades of brown and ochre in the manuscript, while in the mural painting it gives a dark red used for dark drapery of the red clothing. The rubricated names in the manuscript of the *Miracles of Mary* are written in vermilion, as are the legends of the paintings.

Cinnabar is a natural mineral pigment extracted from the Spanish mines of Almadén as well as Altai and Turkestan. Vermilion is an artificial pigment. Cinnabar has been well known since antiquity, and vermilion since the Middle Ages in Europe. The Egyptians and Chinese may have known the recipe for vermilion for at least two thousand years. Oriental painters used vermilion; an Arabian alchemical treaty of the 8th–9th centuries, known as Jabir's treaty, mentions vermilion.²⁴ Different studies have identified HgS in oriental manuscripts.²⁵ As far as mural paintings are concerned, we know that Moghul Indian wall paintings of the 17th century, near Agra, also contain vermilion.²⁶ It is worthy of mention that iconographic similarities have been noticed between the Moghul style and Ethiopian First Gondarine style.²⁷ To date, vermilion has not been found in African artefacts. A systematic study of African red pigments has, however, found the use of ochre (iron oxide), red lead, and organic red pigments.²⁸

Three hypothesis are suggested by the presence of vermilion in Ethiopian manuscript and mural painting. The theory that Ethiopian cinnabar mines existed seems weak; such mines would have been documented in written sources as they would have been rare and given Ethiopia the ability to export cinnabar. The theory that vermilion may have been produced in Ethiopia is unsubstantiated; there is no information about how the recipe would have been known and by whom. The third and most plausible theory is that cinnabar or vermilion were imported into Ethiopia.

Yellow The manuscripts often incorporate bright yellows, similar in hue to a lemon yellow; mural paintings utilise mostly pale yellows. Both shades come from the same source – As_2S_3 , an arsenic sulphur or orpiment. The difference in colour might be explained by the use of different binding agents for painting on parchment and on canvas respectively. Application techniques could also be different; as murals require more surface area coverage the yellow pigment could have been diluted. Orpiment is an ancient pigment which, like cinnabar and vermillion, is found in a natural mineral from Minor Asia, Hungaria and Macedonia, as well as in an artificial form. The artificial form is obtained by precipitation or sublimation. The use of orpiment has been found in ancient Egypt and since antiquity in Europe.²⁹ Orpiment, like cinnabar and vermillion, may have been imported into Ethiopia.

Blue The analysis results for the blue pigment differ for the manuscript and the mural paintings. In both blue is not as widely used as red and yellow. In the murals, blue is only used in large quantity for the cloth of the Virgin Mary, and is thus used in only seven places.³⁰ Blue is also found in small discrete areas, very much diluted, to enhance clothing. In the *Miracles of Mary* it is used for the cloth of Mary and also, in small quantities, for the clothing of other characters.

Results for MS B.N. Ethiopien d'Abbadie 114

The blue colour used in this manuscript is indigo. The analysis results for the original paintings and for the later paintings are the same, which means that the use of the pigment continued through the 17th and 18th centuries. Indigo is an organic substance, vegetal in origin.³¹ When observed under the microscope the samples look very homogenous, which could mean that the indigo colorant was used as a dye instead of as a granular pigment.³² Indigo, extracted from indigo trees (*Indigofera* spp), is also an ancient colour. The Egyptians are recorded as using indigo, and the pigment was known in the Muslim world as early as the 10th century. Its use spread in Sudan and up to North Africa. In Yemen, Zabid was an important centre for the cultivation of indigo.³³ The indigo tree, especially *Indigofera arrecta* and *I. tinctoria*, also grew in Ethiopia.³⁴ Manuel Barradas, a Portuguese Jesuit who was in Tigray in 1634, wrote that he saw indigo growing in Ethiopia, but did not mention whether the plant was a source of blue colour used by the natives. He instead suggested that indigo was an Ethiopian natural resource that the Portuguese could exploit.³⁵ The G'iz name for indigo is *nil*,³⁶ not unlike most of the oriental terms for indigo; it is derived from the Sanskrit word *nili*.³⁷ In studies on five IES icons from the 16th to 18th centuries (IES n. 4,126, 4,190, 4,261, 4,792,³⁸ 4,793) Weihs also identified indigo.³⁹

Results for the Abbä Antonios Murals

Raman microspectrometry revealed the presence of a silicate (Si–O and Si–O–Si). Electronic microscopy also revealed the presence of cobalt.⁴⁰ The blue appears to be a double silicate of potassium and cobalt, which has been known in Europe as smalt since the 16th century. It may be even more ancient than this, however, because it seems that a similar product was used in China and Japan before the 16th century. Smalt is the first blue pigment to use cobalt. This glassy pigment must be ground in a coarse manner so that it does not lose its colouring power.⁴¹ Under the microscope ($\times 1,000$), the grains have a vitreous aspect and contain tiny air bubbles. The angles of intersection are clearly defined. The colour varies from a deep blue for the largest grains to a very light blue for the smaller grains. Weihs has identified smalt on IES icon n. 4,187 which is attributed to the First Gondarine style.⁴² A conclusion attributing indigo to parchment and wood and smalt to canvas can therefore be avoided.

Black The samples were determined to be carbon black, without any phosphate. This result is not surprising as the manufacture of black ink was well known in Ethiopia. My own research on scribes and painters confirms that carbonisation is the main source of the black substance, which can be obtained by burning cereals, plants or other organic material. The substance can also be obtained by collecting the sooty remains.⁴³ The black substance can be used for drawing, painting and writing, as the pigment is stored dry. Dilution and/or the choice of different binding agents varies according to the requirements of the painter.

Green Analysis by Raman microspectrometry yielded no satisfactory result. When observed under the microscope the green samples appeared to be very homogeneous. The green colour may be obtained with an organic colorant, probably vegetal. Many plants are used by Ethiopian painters for producing greens including 'ägam's fruits (*Carissa edulis*), änsusilla's leaves (*Impatiens tinctoria*), arag resa's leaves (*Zehneria scabra*), astänager's leaves (*Datura stramonium*), besanna's leaves (*Croton macrostachyus*), doqma's fruits (*Syzygium guineensis*), and green coloured earth.⁴⁴

Orange This colour is found only in the mural paintings of Abbä Antonios, with shades from pinkish orange to bright orange. All samples appear to be red lead (Pb_3O_4). This is one of the most ancient artificial pigments, obtained by calcinations of white lead (ceruse) or sometimes lead itself. Red lead was used in Europe until the end of the 17th century for illuminated manuscripts, mural paintings and wood panels.⁴⁵

White In the manuscript, white is not used on its own as a colour in the paint layer. There are a few white particles associated with blue in the second set of

paintings, but white particles are found more frequently in the lighter red areas as the addition of white to red producing pink. Raman analysis yielded no results in the identification of the white particles in these areas.

As far as the mural paintings are concerned, whites in the paint layer are identified as anhydrite or anhydrous sulphate of calcium (CaSO_4). Anhydrite was used as white pigment in Ancient Egypt in the mural paintings of Hierakonpolis.⁴⁶ Modern Ethiopian recipes still use limestone (*bäha dāngay*) in the production of white pigment. The whites in the paint layer are different from the white that is seen in the ground layer. It is worth noting that the ground layer does not lay directly on the primary support. Instead, it is applied to a thin surface of yellow-white material that acts as an interlayer between the primary support and the ground layer. The ground layer, the layer that will receive the colours, was identified as gypsum, a natural bi-hydrated sulphate of calcium ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$). In sampling, attempts were made to differentiate the white paint layer – anhydrous sulphate of calcium – from the underlying white ground layer – bi-hydrated sulphate of calcium – in order to avoid conflicting results. Despite this the results were sometimes mixed.

Interpretations and lines for further development

Analysis revealed the use of seven substances including vermilion (or cinnabar), orpiment, and carbon black for both masterpieces; indigo for paintings on parchment only; and smalt, red lead and sulphates of calcium for murals only. Thus a distinction has been made between local pigments and ‘foreign’ ones.

Carbon black, organic green and white sulphates of calcium were probably produced by local painters or craftsmen, since these colours can easily be obtained locally. Their recipes are still well known today.

The presence of vermilion, indigo, smalt, orpiment and red lead raises many issues related to their status as ‘foreign pigments’. Of these five pigments vermilion and orpiment are used quite frequently in our masterpieces, while blue (indigo or smalt) and orange (red lead) are used rarely. Maybe the latter pigments were more expensive or were rare in the Ethiopian marketplace at that time.

Ethiopia was deeply involved in international trade during the Gondarine period.⁴⁷ Ports on the Red Sea such as Aden, Moka, Djeddah, Massawa, Zeyla, Arqiqo and Baylul were prosperous international commercial towns. Goods from Europe, the Middle East and Asia were exchanged at these ports via different Arabian trade groups, the Indian ships lead by the Banyans, the English East India Company, the Dutch Company, and many others. There was considerable competition, and a close study of commercial archives could shed further light on the pigment trade. Travellers’ accounts document precisely the exchange of goods between India and the Red Sea from the 16th century until the end of the 17th century. These accounts report that vermilion, or cinnabar, was imported by India through Aden, with other goods

coming from Italy, Greece and Damascus. Therefore it is quite probable that Ethiopia imported vermillion from this trade route. On the other hand, indigo was exported from East and West India in the direction of the Red Sea ports.⁴⁸

If emperors, royal families and aristocratic patrons had access to these precious pigments, the situation was probably different for rural churches. I made enquiries in the Goğğam and Gondär areas in 1997 and 1998, and spoke with scribes, painters and *dabtaras*, looking for traditional ink recipes. The diversity of these recipes is amazing, and all the colours necessary for a painter's palette can be obtained by using organic and mineral elements found in the local environment. The recipes are transmitted orally, and the quality and intensity of the colours can vary greatly. The one exception is blue, which is very difficult to obtain from local products. Old *dabtaras* remember that blue was imported, some say from Sudan, others from Massawa. By the end of 19th century or beginning of the 20th, ultramarine or laundry bluing may have been used more than indigo or smalt.⁴⁹

My aim here is not to transpose the techniques of modern rural churches onto ancient rural churches; however, this study highlights a popular tradition regarding the use of pigments and their origin which is different from the royal and aristocratic tradition. One problem is what determines the difference between 'low-status', 'non-aristocratic' painting and supposed 'high-status' painting. For the manuscripts, a future study could look to prosopographic and codicological criteria, with some technical data on the use of pigments as well as the quality of the parchment and binding. Analysis of red inks would be interesting, because red is used not only for painting but also for writing the names of divinities and owners. It is therefore present in almost all written as well as iconographic sources. An extensive study of red ink might shed further light on the use of vermillion in Ethiopia.

It would also be interesting to examine whether 'aristocratic' painters were able to produce their own artificial pigments, and when the use of gypsum and lime appeared in mural manufacture. Ethiopian craftsmen are usually not credited with a high level in technological skills,⁵⁰ but as far as painters are concerned very little is known. It is difficult to evaluate the role of Portuguese Jesuits in painting techniques. We know that they had an influence on some iconographic standards by introducing devotional images.⁵¹ Their medium was mainly engraving, however, produced in great quantities for Society of Jesus propaganda, and there is no testimony of any Jesuit who came to Ethiopia being a painter.

The exact timing of the appearance of gypsum and lime for paintings and for the construction of stone buildings is also quite a delicate issue. Did the Portuguese introduced the use of lime into Ethiopia, or was it of Turkish origin?⁵² During medieval times murals were painted on stucco-coated walls, as far as the remaining ones indicate, most of them in the rock-hewn churches of Tigray and Lasta. Scientific analysis of these medieval frescoes would be invaluable in understanding pigment composition, application techniques and composition of the ground layer. If mural paintings on canvas are not known before the 17th

century, the earliest example of mural painted on mounted fabric is a fragment attributed to Fre Şiyon at Daga Estifanos.⁵³ As this fragment has been restored, it is difficult to draw any conclusions about the date of the application layer.

Based on only two masterpieces, this study shows that the pigments used to create them were those favoured amongst aristocratic society of the 17th century, and that most of them were part of the international luxury goods trade of this time.

Notes

This study was begun in 1998 with Mrs Claude Couprie, chemist at CNRS-LADIR and specialist in the analysis of ancient pigments, and Mrs Marie-Thérèse Gousset, Curator in the Manuscript Department at the French National Library.

- 1 We would like to thank Ms Monique Cohen, director of Manuscripts Department of the French National Library, and M Serge Tornay, director of the African Department of Museum of Mankind, for allowing the long and precise task of taking samples. Thanks also to Erica James, restorator of Ethiopian icons at the Smithsonian Institute, Washington, for her valuable help in correcting the English version of this chapter.
- 2 Parchment; 111 folios; 270 × 300 mm; 2 col.; 20 lines per column. See d'Abbadie, *Catalogue raisonné*, pp. 130–1; Conti-Rossini, 'Notice sur les manuscrits éthiopiens de la collection d'Abbadie', pp. 93–9.
- 3 Reproductions in Cerulli, *Storia della letteratura*; Chojnacki, *Major Themes in Ethiopian Paintings*, fig. 142; *L'aventure des écritures*, p. 98.
- 4 It could be a *cheelaes*, a cotton of blue and white stripes, imported during the 17th century. See Van Donzel, *Foreign relations*, p. 185 and p. 252.
- 5 Guidi, *Annales Yohannis I, Iyasu I et Bakaffa*, p. 9.
- 6 Kropp, 'Petite histoire de Yohannes 1', pp. 93, 100.
- 7 Béguinot, *La cronaca abbreviata d'Abissinia*, p. 94; Rüppel, *Reise in Abyssien*, II, p. 361.
- 8 Mercier, *Arche éthiopienne*, pp. 148–9.
- 9 Tekle Tsadik Mekouria, *Les noms propres des rois d'Éthiopie*.
- 10 Heldman, *African Zion*, cat. 13, p. 98. Chojnacki, *Ethiopian Icons*, cat. 27, pp. 319–20. Left panel: *Kwera 'atä Re'esu* and St Georges killing the dragon; central panel: Virgin with Child; right panel: St Gäbrä Mānfās Qiddus and Abbā Arsanyos.
- 11 Heldman, *African Zion*, p. 98, fig. 7. Chojnacki, *Ethiopian Icons*, cat. 79, pp. 343–4. One face depicts St Gäbrä Mānfās Qiddus and the Crucifixion, the other depicts St Georges killing the dragon, and Virgin with Child.
- 12 Chojnacki, *Ethiopian Icons*, cat. 184, pp. 416–17. This large wood panel painting depicts on the left panel The Resurrection, The Flight to Egypt, and St George; on the central panel Virgin with Child and 12 apostles; on the right panel The Crucifixion, abuna Ewostatewos and abuna Täklä Haymanot, Abbā Samu'el and St Gäbrä Mānfās Qiddus.
- 13 For a complete iconographic analysis of those murals see Staude, 'Étude de la décoration picturale', pp. 185–250. Colour reproductions can be found in Leroy, *Ethiopian paintings*, pl. XXI, and Mercier, *L'arche éthiopienne*, p. 132.
- 14 Béguinot, *La cronaca abbreviata d'Abissinia*, p. 96.
- 15 Dating of the church's foundation is discussed in Bosc-Tiessé and Wion, 'Inventaire des peintures datées du XVII^e au début du XIX^e siècles', p. 222.
- 16 Staude, 'Étude de la décoration picturale', pp. 185–250.
- 17 Wion, 'Les peintures murales de Qoma Fasilädäs'.
- 18 They may soon be transferred to the new Museum of Quai Branly.
- 19 *In situ* analysis could be carried out, but as far as our study is concerned it would create problems related to historical artefacts' transportation and manipulation.

- 20 For a clear and concise presentation of Raman methodology see Couprie, 'Étude des pigments', pp. 119–26. For a very detailed presentation see Turrell (ed.), *Raman Microscopy*.
- 21 For a comparative table of different processes of molecular analysis, with advantages and inconveniences, see Clark and Gibbs, 'Raman Microscopy', p. 100.
- 22 Raman cannot make a distinction between cinnabar and vermilion.
- 23 See the fully documented study of Gettens, Feller and Chase, 'Vermilion and cinnabar'.
- 24 For Armenia, see Mathews, 'A pigment analysis of Medieval Armenian Manuscripts'. For Persian and Syriac manuscripts see the studies of R.J.H. Clark.
- 25 Nagpall, 'Analysis of some Moghul wall paintings materials', pp. 122–5.
- 26 Fabo-Perczel, 'Ethiopian paintings', p. 166; Leroy, *Ethiopian paintings*, p. 40.
- 27 Portell, 'African red pigments', pp. 119–29.
- 28 Petit, *Des liants et des couleurs*, p. 251ff.
- 29 Virgin with Child; Visitation; Adoration of the Magi; Nativity; Flight to Egypt; Crucifixion; Covenant of Mercy.
- 30 We are grateful to the Musée du Louvre, whose modern spectrometer identified indigo.
- 31 A colorant dissolves itself in the binding agent, but a pigment cannot be dissolved and melts with the binding agent. The same product can be pigment or colorant, according to the application method, as it is the case of indigo.
- 32 Arabian geographers Ibn-Hawqal, Idrisi and Muqqadasi gave important information about indigo's expansion. See Cardon, *Guide des teintures naturelles*, p. 144.
- 33 Ibid, p. 141; Edwards, *Flora of Ethiopia and Eritrea*, III, pp. 119–35; *Indigofera arrecta*, *Indigofera articulata*, *Indigofera coerulea* and *Indigofera tinctoria* species are used for colouring and all grow in Ethiopia. *Indigofera arrecta* (*degendeg* in Amharic) grows at 1000 to 2700 m.
- 34 Barradas, *Tractatus Tres Historico-Geographici*, p. 35.
- 35 Leslau, *Comparative Dictionary of Ge'ez*, p. 398.
- 36 This lexical root is common to Hindustani (*nil*), Tamil (*nili*), Malay (*nilam*), Persian (*nilah*) Arabian (*an-nil*) and Spanish (*anil*). In the Roman Empire, then in Europe, this product was called 'that comes from India', which gives 'indigo'. See the exhibition catalogue *Sublime Indigo*, p. 47.
- 37 See Chojnacki, *Ethiopian Icons*, cat. 187: this triptych is quite similar in its composition and style to IES 4,755 (see n. 12).
- 38 Weihs, 'Einige technische Details zu äthiopischen Ikonen', in Marx, 'Indigo, Smalt, Ultramarine', p. 2.
- 39 As samples are destroyed by this technique, we used only half of one sample.
- 40 Mühlethaler and Thiessen, 'Smalt', pp. 47–61; Gettens and Stout, *Painting Materials*, p. 157.
- 41 Weihs, 'Einige technische Details zu äthiopischen Ikonen', in Marx, 'Indigo, Smalt, Ultramarine', p. 2.
- 42 See also Godet, 'Une méthode traditionnelle de préparation de l'encre noir en Éthiopie', pp. 211–17.
- 43 Recipes collected during two field trips in Goğgam, Gondär and South-Gondär during 1997 and 1998. See also Taye Wolde Medhin, 'La préparation traditionnelle des couleurs en Éthiopie', pp. 219–24.
- 44 Petit, *Des liants et des couleurs*, pp. 216–18.
- 45 Ibid., p. 66.
- 46 Pankhurst, 'The history of Ethiopia's relations with India'; Van Donzel, *Foreign relations of Ethiopia*. (None of the lists of objects exchanged during diplomatic embassies report pigments).
- 47 According to Tomé Pires, in Cortesão, *The Suma Oriental of Tomé Pires*, London, 1944, pp. 42–6; according also to Barbosa, in M.L. Dames, *The Book of Duarte Barbosa*, London, 1918, I, p. 77. Then in 1618, in the report of Baldaeus, in Baldaeus, 'An exact description of the coasts of Malabar and Coromandel in the East Indies', in A. Churchill, *A Collection of Voyages and Travels*, London, 1755, III, pp. 520–2. All are quoted by Pankhurst, 'The History of Ethiopia's relations with India', pp. 231, 234, 272–3.
- 48 Marx, 'Indigo, Smalt, Ultramarine'.

- 49 Merid Wolde Aregay, 'Society and technology in Ethiopia', pp. 127–9.
50 Monneret de Villard, 'La Madonna di Santa Maria Maggiore'; Chojnacki, *The Kwer'ata re'seu*.
51 Merid Wolde Aregay, 'Society and technology', pp. 134–7.
52 Heldman, *The Marian Icons of the Painter Fre Seyon*, pp. 51–2; Bosc-Tiessé, 'L'histoire et l'art des églises du lac Tana', pp. 264–5. Reproduction in Chojnacki, *Major Themes in Ethiopian Paintings*, Fig. 207.